Université de Sherbrooke

Concordance des décisions cliniques d'un modèle de collaboration interdisciplinaire en clinique externe impliquant un stagiaire en physiothérapie et les chirurgiens orthopédistes

Agreement of clinical decisions in an interdisciplinary collaborative outpatient clinic model involving a physiotherapy trainee and orthopedic surgeons

Par
David Yin, MD

Mémoire présenté à la Faculté de médecine et des sciences de la santé en vue de l'obtention du grade de Maître ès sciences (M. Sc.) en recherche en sciences de la santé

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Sommaire

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Programme de recherche en science de la santé

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Les physiothérapeutes en pratique avancée (PPA) ont permis l'amélioration de l'accessibilité aux cliniques externes en orthopédie. Plusieurs études ont validé le modèle de pratique PPA en soins orthopédiques, démontrant une concordance élevée entre les PPA et les chirurgiens orthopédistes (CO) sur le diagnostic et la prise en charge. Les PPA sont généralement des physiothérapeutes séniors expérimentés et un modèle de pratique avec un stagiaire en physiothérapie (SP) n'a jamais été exploré. Le but de cette étude était donc d'évaluer la concordance pour les diagnostics et pour le triage chirurgical entre un SP et des CO. Une étude prospective impliquant un SP dans sa dernière année d'étude et sept CO a été menée à un hôpital universitaire, après que le SP ait suivi une formation intensive de trois semaines. Les patients adultes référés en orthopédie pour gonarthrose, coxarthrose ou problèmes d'épaule ont été évalués individuellement par le SP et ensuite par un CO. Les diagnostics et recommandations de triage chirurgical des deux cliniciens ont été analysés pour concordance utilisant le pourcentage d'accord brute et le kappa de Cohen. La satisfaction des patients envers leurs expériences en clinique externe a été notée comme issue secondaire utilisant une version modifiée du Visit-Specific Satisfaction Instrument. Notre échantillon comprenait 86 patients (âge moyen = 63.4ans). Les problèmes d'épaule représentaient 36% des consultations, la gonarthrose 52% et la coxarthrose 12%. La concordance brute pour le diagnostic était de 95.3%. La concordance pour le triage chirurgical était élevée (κ = 0.86, IC 95%: 0.74–0.98) avec une concordance brute de 94.2%. La satisfaction des patients était élevée. Donc, le SP et les CO ont posé des diagnostics et triages similaires. Ceci suggère que l'expérience clinique seule ne détermine pas la capacité du physiothérapeute à améliorer l'accessibilité en orthopédie.

Mots-Clés : accessibilité, équipe interdisciplinaire, pratique avancée, physiothérapeute, soins orthopédique, triage chirurgical, étude de concordance inter-évaluateurs

Summary

Agreement of clinical decisions in an interdisciplinary collaborative outpatient clinic model involving a physiotherapy trainee and orthopedic surgeons

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Thesis presented to the Faculty of Medicine and Health Sciences in order to obtain the maitre ès sciences degree (M.Sc.) in Research in Health Sciences,
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Advanced practice physiotherapists (APP) have helped improve accessibility to orthopedic outpatient care. Several studies have validated the APP practice model in orthopedic care, demonstrating high agreement between APPs and orthopedic surgeons (OS) regarding diagnosis and management. However, as APPs tend to be experienced senior physiotherapists, such a study involving a physiotherapy student (PS) has not yet been explored. The purpose of this study was to evaluate agreement for orthopedic diagnoses and surgical triage between a PS and OSs. A prospective study involving a final year PS and seven OSs was conducted in a university hospital, after the PS had undergone a three-week intensive training. Adult patients referred to OSs for gonarthrosis, coxarthrosis or shoulder problem were independently evaluated by the PS, and then re-evaluated by an OS. The diagnoses and surgical triage recommendations of both clinicians were analyzed for agreement using percentage agreement and Cohen's kappa. Patient satisfaction towards the outpatient clinic experience was noted as a secondary outcome using a modified version of the Visit-Specific Satisfaction Instrument. Our sample consisted of 86 patients (mean age = 63.4 years). Reasons for consultation included shoulder problems (36%), gonarthrosis (52%) and coxarthrosis (12%). The percent agreement for diagnosis was 95.3%. The agreement for surgical triage was high ($\kappa = 0.86$, 95% CI: 0.74–0.98) with a raw agreement of 94.2%. Patient satisfaction was high. Therefore, the results showed that the PS and OSs made similar diagnoses and triage recommendations. This suggests that clinical experience alone is not a prerequisite for physiotherapists to help increase accessibility to orthopedic care.

Keywords: Accessibility, Interdisciplinary Team, Advanced Practice, Physiotherapist, Orthopedic Care, Surgical Triage, Inter-rater Agreement Study

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List of Abbreviations and Symbols

APP:	Advanced practice physiotherapist
ESP:	Extended scope physiotherapist
OS:	Orthopedic surgeon
PS:	Physiotherapy student
RCT:	Randomized controlled trial
VSQ-9:	Visit-Specific Satisfaction Instrument
95% CI	95% confidence interval

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Chapter 1: Introduction

The current landscape of orthopedic medicine in the province of Quebec is plagued by inadequate access to care and work overload for orthopedic surgeons (OS). Wait times to be seen in an orthopedic clinic can seem endless for patients, sometimes exceeding two years when chronic, non-urgent afflictions are involved (F. Desmeules et al., 2012). Moreover, the need for orthopedic consultations is estimated to increase as the population continues to age and overweight/obese patients become more prevalent (Aiken, Harrison, Atkinson, & Hope, 2008; Shipton, Badley, & Mahomed, 2003). There exists a considerable shortage of doctors; the number of OSs in Quebec is 4.5 per 100,000 people (CMA, 2018), which falls short of the ideal requirement of 6 per 100,000 people (Lee, Jackson, & Relles, 1998). The continuously decreasing number of orthopedic residents recruited year by year further contributes to the lack of OSs in Canada (CaRMS, 2018). Insufficiencies in primary care (e.g. lack of general practitioners, inadequate accessibility to first line medicine, etc.) lead to increased unnecessary referrals to specialists (Shi, 2012), which contribute as well to the work overload.

The present practice in orthopedic medicine in Canada is doctor-centered. In this type of practice model, doctors are inevitably the limiting factor to increasing accessibility of care. Providing assistance for OSs would help improve accessibility while reducing workload for these physicians. In certain countries, a new practice model has become more and more prevalent involving physiotherapists being introduced into orthopedic outpatient clinics and substituting doctors in many of their responsibilities (Darryn Marks, 2016; Oakley & Shacklady, 2015). This would, as a result, free OSs so that they may perform more complicated tasks. Toronto's Sunnybrook Holland Centre is a pioneer in this type of interdisciplinary teams in Canada (Kennedy, Robarts, & Woodhouse, 2010; Razmjou et al., 2013). In Quebec, similar practices have taken place at Hôpital Jean Talon and Hôpital Maisonneuve-Rosemont (Decary et al., 2017; Fernandes, 2017).

In the current literature, the great majority of studies seeking to evaluate this new model of practice with physiotherapists as team members in orthopedic outpatient clinics have involved senior physiotherapists with numerous years of work experience (François Desmeules, 2011; Stanhope, Grimmer-Somers, Milanese, Kumar, & Morris, 2012). There

has yet to exist a study conducted to validate such a practice model with physiotherapy students in training. Information drawn from such a study could provide a platform from which training programs for these physiotherapists could be developed.

In this context, the general purpose of this study is to investigate a collaborative model of care involving a senior physiotherapy student (PS) in orthopedic outpatient clinics. An inter-rater agreement study was conducted to evaluate the level of agreement between a PS and OSs in clinical decisions.

Chapter 2: Key Concepts

As the current study concerns a collaborative model of care between physiotherapists and OSs in orthopedic outpatient clinics, this chapter will provide context in regards to the key concepts of this study. Topics such as interdisciplinary teams, traditional practice of physiotherapists and advanced practice physiotherapists in orthopedic clinics will be discussed here.

2.1: Interdisciplinary Teams in Healthcare

"Interdisciplinary team work is a complex process in which different types of staff work together to share expertise, knowledge, and skills to impact on patient care" (Nancarrow et al., 2013). Interdisciplinary work is becoming more and more desired due to the challenges of providing comprehensive care to an increasing aging patient population with chronic diseases (Nancarrow et al., 2013). When applied in healthcare, it has been demonstrated to improve quality of care, yield greater satisfaction for both patients and staff members and reduce costs associated with care (Nancarrow et al., 2013). In attempts to facilitate interdisciplinary work, the province of Quebec passed the Bill nº90 which defines the scope of practice for each healthcare professional and declares certain tasks unique and protected for each discipline (Québec, 2002).

While specific tasks may be limited to each profession, a healthcare professional taking on greater responsibilities is not novel to Quebec. In fact, these advanced practice roles are becoming increasingly sought after in today's medical practice because of their potential to increase accessibility to care and decrease workload for physicians (F. Desmeules et al., 2013). Nursing provides a typical example with their nurse clinicians and specialized nurse practitioners (OIIQ, 2017a; Sawatzky-Dickson & Roussel, 2010). Efforts have been made to introduce advanced practice roles in other healthcare disciplines such as physiotherapy (F. Desmeules et al., 2012).

2.1.1: Advanced Practice in Nursing

Nurses have had their roles expanded in positions such as the clinical nurse specialist and nurse practitioner (OIIQ, 2017a). Clinical nurse specialists operate within the

scope of nursing practice and offer clinical expertise in a specialty area (Sawatzky-Dickson & Roussel, 2010). They play a leading role in the development of clinical guidelines and protocols (Sawatzky-Dickson & Roussel, 2010) and are often in the coordinating role when delivering care and services (OIIQ, 2017a). Nurse practitioners can work outside the scope of traditional nursing practice and provide direct care to patients (Sawatzky-Dickson & Roussel, 2010). These nurses perform tasks such as diagnosing autonomously, ordering and interpreting diagnostic tests, prescribing pharmaceuticals and executing specific procedures (Sawatzky-Dickson & Roussel, 2010).

Collective prescriptions have helped facilitate nurses in taking on expanded roles (OIIQ, 2017b). They are defined as a prescription given by a doctor or group of doctors to a healthcare professional for a set group of patients or clinical situations with circumstances in which they can be administered as well as contraindications (OIIQ, 2017b). These collective prescriptions can include medications, treatments, investigations and care (OIIQ, 2017b) and allow experienced nurses to exert their clinical expertise without direct supervision of a doctor (OIIQ, 2017b).

2.1.2: Practices of Musculoskeletal Physiotherapists

2.1.2.1: Current Practice of Musculoskeletal Physiotherapists

As stated above, Quebec's Bill nº90 defines the scope of practice for each health professional (Québec, 2002). Traditionally, the role of musculoskeletal physiotherapists has been limited to evaluating and treating the impairment and disability of physical function. They are tasked at determining and carrying out treatment plans that help establish an optimal function level for patients. Physiotherapists can achieve this through patient education, prescribing exercises, specific manual therapy and using forms of invasive energy. Also listed in Bill nº90, but not commonly performed by physiotherapists in Quebec, are therapeutic joint injections. Physiotherapists are permitted to perform this technique if they have received certified training.

Recent changes in the province of Quebec have allowed an expansion of the scope of practice of physiotherapists. One of these changes involves the collaboration of pharmacists and physiotherapists in communicating patient information for optimal

management of pharmaceutical treatments (OPPQ, 2015). When a physiotherapist deems that an over-the-counter medication therapy could benefit a patient, the physiotherapist can now suggest to pharmacists, through the use of a standardized form, the medications that should be added to the patient's treatment regimen. With the patient's information and the physiotherapist's recommendations, the pharmacist could then adjust the patient's medications appropriately.

Physiotherapists can also collaborate with other health professionals through referrals. This includes referrals to specialist physicians. Physiotherapists are in fact obligated to refer their patients to specialists when the health condition of their patient demands it according to their code of deontology (Laurent, 2016). Nevertheless, it is the responsibility of the physician who receives the referral to diagnose the patient, order further exams and initiate treatment according to the patient's clinical situation (Laurent, 2016). The right to refer does not grant physiotherapists the right to make medical diagnoses which remain reserved to the medical profession (Laurent, 2016; Québec, 2002).

Physiotherapists have for some time now been allowed to recommend walking aids to their patients (OPPQ, 2017). However, the benefits of this privilege are limited by regulations brought forth by health insurance providers (OPPQ, 2017). For reimbursement of walking aids, they must be prescribed by authorized prescribers which are most often limited to physicians as dictated by health insurance providers (OPPQ, 2017). The Ordre professionnel de la physiothérapie du Québec firmly believes that physiotherapists are well trained and competent enough to prescribe such walking aids (OPPQ, 2017).

2.1.2.2: Advanced Practice Physiotherapists in Orthopedics

Similarly to nurses, advanced practice roles have started to appear in physiotherapy. Currently, there exist two main titles given to physiotherapists taking on greater roles. An advanced practice physiotherapist (APP) is often defined as a physiotherapist with greater responsibilities than what is common but within the defined professional scope (Darryn Marks, 2016; Stanhope, Grimmer-Somers, et al., 2012). An extended scope physiotherapist (ESP) is defined as a physiotherapist taking on a role beyond the usual scope of the profession (Darryn Marks, 2016; Stanhope, Grimmer-Somers, et al., 2012). The exact differences between an APP and an ESP can be difficult to characterise. "Normal scope of

practice" can vary immensely between countries and even between provinces. These two terms are often used interchangeably in the literature. Thus, for simplicity, the term APP will be used.

APPs often collaborate with orthopedic surgeons. Assignments most frequently given to these APPs include management of referrals, triage of patients for surgical consultation and monitoring of non-surgical and postoperative orthopedic patients (François Desmeules, 2011; Razmjou et al., 2013). Specific tasks can comprise of administering therapeutic injection, removing of plasters and K-wires, ordering further investigations, prescribing medications, requesting referrals to other health professionals and specialists and listing patients for surgery (François Desmeules, 2011; Stanhope, Grimmer-Somers, et al., 2012). According to some studies, 55% to 90% of patients referred for consultation in orthopedic surgery are not candidates for surgery (François Desmeules, 2011). Thus, a skilled APP would theoretically be able to help OSs manage a great portion of their patients.

Most APPs have extensive experience in their profession. They frequently have multiple years of work experience in musculoskeletal physiotherapy (François Desmeules, 2011; Stanhope, Grimmer-Somers, et al., 2012). Further training is generally required and can include postgraduate degrees, fellowships in orthopedics and site-based training (Stanhope, Grimmer-Somers, et al., 2012). The latter involves shadowing physicians in their outpatient clinics, attending courses on clinical knowledge and imaging interpretation as well as receiving constant feedback on their performance (Stanhope, Grimmer-Somers, et al., 2012). Nevertheless, a standardized training program for developing APPs has yet to be established (François Desmeules, 2011).

2.2: Models of Advanced Practice Physiotherapists and Orthopedic Surgeons

Three main practice models have been used for APPs in orthopedic outpatient clinics (Fernandes, 2017) : 1) a collaborative model; 2) a parallel model; and 3) an autonomous model. In the collaborative model (Fernandes, 2017), the APP and OS work in unison. The APP sees the patient first and then reports to the attending OS. Afterwards, the doctor concludes the encounter with the patient. In a parallel model (Fernandes, 2017), both the APP and OS run separate outpatient clinics in parallel at the same location. Both

can become available to help the other if needed. Finally, in the autonomous model (Fernandes, 2017), the APP becomes an independent clinician. The APP sees patients and manages them as well as discharges them. However, an OS is readily available outside of the outpatient clinic (e.g. in the operating room) if the APP requires help.

Each model has its own advantages and disadvantages in terms of efficiency, efficacy and utilisation of resources (Fernandes, 2017). According to a study conducted by Fernandes *et al* (Fernandes, 2017), an OS in a standard orthopedic outpatient clinic model required two nurses and two orderlies to function and could see an average of a patient every 12 min. In contrast, in a collaborative model where an OS worked alongside a nurse, an orderly and an APP, a patient was seen every 9-10 min, which amounted to a 20% to 40% gain in efficiency. In a parallel model, both the APP and OS could see a patient every 12 min on average, doubling the efficiency of an OS. Of course, this last model is heavily resource dependant as each clinician requires nurses, orderlies and exam rooms. In an autonomous model, the APP could generally see a patient every 12 min while the OS works on something else at a distance, therefore potentially adding extra days of orthopedic outpatient clinics. It should be noted that each subsequent model presented requires more and more autonomy on the part of the APP.

2.3: Current Experience with Advanced Practice Physiotherapists in Orthopedic Care

The same problems with accessibility to orthopedic surgery experienced in Canada have also been observed elsewhere in the world. The United Kingdom, Sweden and Australia have slowly implemented measures to facilitate the integration of APPs into their health care systems (Darryn Marks, 2016; Oakley & Shacklady, 2015; Samsson, Bernhardsson, & Larsson, 2016). Triage of patients on waiting lists for orthopedic surgery is a common role played by these APPs (F. Desmeules et al., 2013).

The orthopedic team at Sunnybrook's Holland Centre is a pioneer of APP in Canada (Sunnybrook, 2017). The Holland Centre employs an autonomous model for their APPs who are the first point of contact for referred patients. The APPs handle referral management (surgical triage and prioritization), patient assessment, as well as patient education on community resources and treatment options. When patients are triaged as surgical, the APPs refer them to OSs. If not, they manage the patients conservatively. APPs

working at the Holland Centre also ensure postoperative routine follow-up of discharged patients.

Hôpital du Sacré Cœur de Montréal was one of the first to introduce an APP to the province of Quebec (F. Desmeules et al., 2013). Hôpital du Sacré Cœur de Montréal is a supra regional university hospital with a tertiary trauma center. Their APP would see patient from the orthopedic surgery department's waiting lists in a collaborative model outpatient clinic. The APP evaluated patients through questioning, examining, interpreting imagery, establishing diagnoses, ordering further investigations and recommending treatment options under the supervision of an OS.

After the success experienced at Hôpital du Sacré Cœur de Montréal, a permanent APP position was installed at the orthopedic outpatient clinics of Hôpital Jean Talon (Fernandes, 2017). Their APP works according to either a collaborative or autonomous practice model. Due to resource limitations (e.g. lack of examination rooms), a parallel model was more difficult to implement. The APP is allowed to establish diagnoses, order further investigations, recommend management autonomously and discharge patients. The OS's approbation is however required for certain acts such as ordering advanced imagery (e.g. MRI and bone scintigraphy), prescribing medications and orthotics, administering joint injections, referring patients to other doctors and filling out official forms. When these acts are required by the APP, the OS, who is usually in the operating room, goes to the clinic and approves the required acts between cases.

Chapter 3: Literature Review

This chapter will present a review of the current literature focussing on surgical triage by APP in orthopedic clinics. The review will focus on studies that evaluated the clinical competencies of APPs required in their role in collaborating with orthopedic surgeons. Considering that managing new referrals to orthopedic surgery is a frequent task assigned to APPs (F. Desmeules et al., 2013), the clinical competencies required by APPs include establishing diagnoses, determining surgical cases and conservatively managing patients (Decary et al., 2017; F. Desmeules et al., 2013).

3.1: Diagnostic Concordance between Advanced Practice Physiotherapists and Orthopedic Surgeons

In attempts to validate orthopedic APPs, much research has been undergone to evaluate the abilities of APPs to correctly diagnose musculoskeletal conditions. A common type of study compares diagnoses established by APPs to those of OSs. In these studies, the diagnoses of OSs are assumed to be the gold standard. Thus, a high diagnostic concordance between APPs and OSs would confirm that APPs possess adequate competences to diagnose patients in an orthopedic setting.

The first study to evaluate diagnostic concordance between a physiotherapist and an OS was conducted by Aiken and McColl (Aiken & McColl, 2008). A total of 30 patients referred to an outpatient orthopedic clinic in Kingston, Ontario, Canada for shoulder or knee problems were assessed independently by a physiotherapist followed by an OS. Each healthcare provider noted the primary diagnosis for their patients using the International Classification of Diseases (ICD-9) codes, which was analysed for agreement. An overall percent agreement of 90% was obtained for all knee and shoulder diagnoses. Although Aiken and Mcoll obtained a high diagnostic agreement, their small sample size, which includes only six patients with shoulder problems, limits the generalisation the results. Furthermore, complex referrals were excluded.

Desmeules *et al* (F. Desmeules et al., 2013) performed a similar study on a larger scale (n = 120). They sought to validate an APP model of care in an orthopedic outpatient clinic at Hôpital du Sacré Cœur de Montréal (Montreal, Canada). An experienced senior

physiotherapist (30 years of experience in sports and orthopedic physiotherapy) had participated in a residency-type training program for 11 months prior to the study in order to prepare for his APP role. The APP was tasked at seeing initial consults for hip or knee complaints. Both the APP and OS would evaluate each patient and establish diagnoses for orthopedic conditions independently. They were asked to classify their diagnoses using six categories for the knee (1. osteoarthritis, 2. ligament tear/rupture, 3. meniscal injury, 4. patellofemoral syndrome, 5. other and 6. undetermined) and five for the hip (1. osteoarthritis, 2. hip impingement syndrome, 3. tendonitis/bursitis, 4. other, 5. undetermined). The overall diagnostic agreement was 88% (89% for knee conditions and 82% for hip conditions) with a kappa of 0.86 (95% CI: 0.80–0.93). The agreement increased to 93% when secondary diagnoses were considered. Taking secondary diagnoses into account better simulates the reality of clinical practice as different clinicians prioritize differently. Concordance of the diagnoses made by the APP and OSs was verified by two independent reviewers, increasing the rigor of their analyses. Although the use of diagnostic categories permitted the calculation of kappas, this circumspection could overestimate concordance as nuances in diagnoses were possibly lost. This limitation is especially profound for the use of an "other" diagnostic category which could result in agreement in cases with differing diagnoses. Generalisation of the results can be critiqued as well since only one senior physiotherapist was evaluated.

Similarly, Razmjou *et al* (Razmjou et al., 2013) also conducted a prospective study on diagnostic agreement with an APP practice model at the Holland Centre (Toronto, Canada). The APP in their study possesses advanced degrees and underwent a 3-month on-site residency type training program. A hundred patients with shoulder problems who were referred to their specialty shoulder clinic were evaluated by both the APP and OS. As done in the previous study, clinical diagnoses were placed into seven major categories based on etiology and location of structure involved (1. rotator cuff pathology, 2. biceps pathology, 3. osteoarthritis in the glenohumeral and acromioclavicular joints, 4. instability-related pathologies, 5. inflammatory conditions, 6. superior labral anterior and posterior pathologies and 7. other). Some of these major categories had sub-categories which allowed more refined diagnoses. Unlike other similar studies, agreement was calculated for each individual diagnostic category. Summarily, agreement on the major diagnostic

categories varied from good to very good (κ = 0.63−0.86). Raw percent agreement varied from 84% (osteoarthritis in the acromioclavicular joints) to 98% (inflammatory conditions). Although not specified, it appears that diagnostic categories were not mutually exclusive; patients could be diagnosed with multiple pathologies. This study is limited by the comparison of only one senior physiotherapist to one OS which may decrease the external validity. Additionally, patient history was noted using a standardized form by the APP and shared with the OS. The use of a standardized form for history taking may have biased the clinicians, bringing their attention to specific information they may not have obtained normally.

Mackay *et al* (MacKay, Davis, Mahomed, & Badley, 2009) evaluated diagnostic concordance in 62 patients referred to OSs for total joint replacement of the knee (n = 45) or hip (n =17) at a teaching hospital setting in Toronto, Canada. Two experienced physiotherapists (average of 17.5 years of clinical experience) with special training in arthritis management participated in the study. Patient assessment was performed independently by the APPs and OSs. The APPs and OSs agreed on the diagnosis of 69% of cases. The most common reason for discrepancies were between a diagnosis of osteoarthritis versus meniscus/ligament injury and osteoarthritis versus inflammatory arthritis. Despite having evaluated two APPs, both were very experienced and specifically trained to manage the types of problems encountered in the study. Therefore, these results may not apply to other physiotherapists with less substantial training.

A prospective study by Décary *et al* (Decary et al., 2017) sought to evaluate the capabilities of an APP correctly diagnose 179 patients with knee pathologies relying exclusively on his musculoskeletal examination (blinded to imaging results). The study was conducted in both an orthopedic clinic and primary care family medicine clinic settings in Montreal, Canada with an APP that had one year of clinical experience. The APP performed solely a musculoskeletal examination of the patients while the physicians had access to imaging results during their evaluations. Five classification categories for diagnoses (ACL injury vs. meniscal injury vs. patellofemoral pain vs. osteoarthritis vs. other) were used. Overall inter-rater agreement was high (κ = 0.89; 95% CI: 0.83−0.94) with a percent agreement of 92.2%. The study is unique in its blinding of imaging results for the APP and was able to demonstrate that a musculoskeletal examination alone may

allow clinicians to correctly diagnose knee disorders. The strength of this study is its multi-center design, including a primary care setting. However, few patients (8%) were recruited from the family medicine unit. In spite of having a less experienced physiotherapist compared to other studies (Aiken & McColl, 2008; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013), that physiotherapist was the only one evaluated which could possibly limit the external validity.

Several systematic reviews have also concluded good diagnostic agreement between APPs and OSs (Darryn Marks, 2016; F. Desmeules et al., 2012; Oakley & Shacklady, 2015; Stanhope, Grimmer-Somers, et al., 2012). On the other hand, a systematic review conducted by Stanhope *et al* (Stanhope, Beaton, Grimmer-Somers, & Morris, 2012) explored the role of APPs in managing patients with inflammatory arthropathies. The review included four studies, none meeting their inclusion criteria for critical appraisal. There were no studies that evaluated the effectiveness in terms of health outcomes, costs and process measures of APPs handling inflammatory arthropathies and so Stanhope *et al* concluded that the advantages of implementing APPs encountered in the orthopedic setting did not apply for rheumatologic disorders at the moment.

In conclusion, there is a high level of agreement between APPs and OSs pertaining to clinical diagnoses, supporting the capacity of physiotherapists to make adequate clinical diagnoses in patients suffering from musculoskeletal problems. Although having very positive results, these studies may not be generalizable as most involved only one APP in one clinical setting and few types of problems encountered. Furthermore, in the majority of studies, only experienced senior physiotherapists (> 5 years of experience) were involved.

3.2: Surgical Triage Concordance between Advanced Practice Physiotherapists and Orthopedic Surgeons

A crucial role for APPs is triaging potential surgical candidates (F. Desmeules et al., 2013). Strong performance in this task is what could impact most positively accessibility to orthopedic care. The OSs would be spared of unnecessary orthopedic referrals which would be managed by APPs while cases requiring intervention of OSs would be rightfully referred. Most studies evaluating diagnostic concordance, as presented

in the precedent section, also evaluated concordance for surgical triage (Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013).

The prospective study by Desmeules *et al* (F. Desmeules et al., 2013) also evaluated surgical triage concordance between an APP and OSs for knee and hip problems. After an independent evaluation of patients, both the APP and OS made recommendations regarding treatment approach. Each clinician decided whether a case was conservative, surgical or undecided. In their study population, only 31% of cases (n = 37) were deemed surgical. The treatment approach concordance was high ($\kappa = 0.77$; CI 95%: 0.65−0.88) and overall percent agreement was 88%. Four out of the 37 surgical cases were classified differently by the APP. A possible bias exists with the undecided treatment approach due to its vague definition; it could be difficult for clinicians to agree on what constitutes an undecided case. Accordingly, the raw percent agreement was only 30% for cases categorized as undecided.

Surgical triage concordance between an APP and OSs for shoulder pathologies was evaluated by Razmjou *et al* (Razmjou et al., 2013). A simpler approach was used for surgical triage recommendations. After evaluating each patient, both the APP and OS individually decided whether a patient required a surgical intervention or not, forcing each to commit more strongly to their choice of treatment approach. Their results showed that the APP had a tendency to suggest more surgeries than the OS, but a good agreement was still achieved ($\kappa = 0.75$; 95% CI: 0.62−0.88). Percent agreement for surgical triage was 88%. Among patients deemed surgical by the OS (n = 55), six were classified differently by the APP.

Mackay *et al* (MacKay et al., 2009) evaluated surgical triage for total hip arthroplasties and total knee arthroplasties. The primary objective of their study was to compare clinical recommendations concerning the appropriateness of patients to be seen by an OS and the candidacy of the patient for undergoing a total joint replacement. Both the APP and OS made these recommendations after independently evaluating each patient. They agreed 91.8% of the time ($\kappa = 0.69$) on the appropriateness of the orthopedic consultations. When there was a disagreement, the APPs tended to refer the patient to an OS more often than not (4/5 cases), demonstrating a more secure approach. Among

patients seen, 43.5% were deemed candidates for a total joint replacement. Surgical triage concordance between the APPs and OSs was 85.5% with a kappa of 0.70. In cases deemed surgical by the OSs, 8 patients out of 27 were triaged as conservative by the APPs. However, in all discordant cases, the APPs recommended that the patient was appropriate for consultation and thus would be seen by an OS. The additional agreement component for appropriateness for consultation better simulates the reality of this type of practice model.

The study performed by Décary *et al* (Decary et al., 2017) where their APP's evaluation of patients was exclusively based on his musculoskeletal examination also evaluated surgical triage concordance with OSs. After evaluation, both the APP and OS triaged the treatment approach of their patients as surgical, conservative or uncertain. In their cohort, only 13% of patients were deemed surgical. The overall agreement between the clinicians was good ($\kappa = 0.73$; 95% CI: 0.60−0.86) with a raw percent agreement of 91.6%. Only two of the 23 surgical cases were classified differently by the APP. Raw agreement for uncertain cases was low (66.7%), suggesting once again possible misinterpretations of this category. The APP achieved comparable results to other studies in the literature while being deprived of useful imaging results, suggesting that a well performed medical examination alone can help guide treatment approach in these patients.

APPs possess good clinical judgement in regards to surgical triage, as they appear to make similar recommendations as OSs. Only a small proportion of surgical patients were classified differently as requiring conservative care. Nevertheless, in most of these cases, the discordant cases were referred to the OS, exhibiting the APPs' cautious tendencies. Furthermore, surgical triage may vary among OSs (Grove, Johnson, Clarke, & Currie, 2016). It is thus not a realistic goal to aim for perfect agreement between OSs and APPs.

3.3: Diagnostic Accuracy of Physiotherapists for Orthopedic Conditions

Another way of evaluating the diagnostic capabilities of APPs is to compare their diagnoses to findings from more reliable diagnostic modalities. In orthopedic medicine, these diagnostic modalities often include complex imaging (e.g. MRI and CT-scan) and findings observed during surgery. One may critique that findings from imaging test do not always correlate with clinical presentation (Borenstein et al., 2001). Nevertheless, this type

of diagnostic accuracy study sheds a light on APPs' competences from a different perspective.

One such study is a retrospective diagnostic accuracy study led by Moore *et al* (Moore et al., 2005) which compared the clinical diagnoses for acute musculoskeletal conditions made by US Army physiotherapists, OSs and non-orthopedic healthcare providers (which included nurse practitioners, general practitioners and emergency doctors) to MRI findings. It should be noted that the US Army physiotherapists were often the first to diagnose and manage patients with musculoskeletal problems, essentially assuming the role of an APP. The files of patients seen by the various clinicians were reviewed and clinical diagnoses were noted. The imaging findings of those who had undergone an MRI for their condition were compared to their clinical diagnosis. It was found that the physiotherapists achieved 74.5% diagnostic accuracy while OSs achieved 80.8% and non-orthopedic providers achieved 35.4%. No statistically significant difference was found between the physiotherapists and the OSs while the diagnostic accuracy of both physiotherapists and OSs differed significantly from the non-orthopedic providers. The study was limited in its retrospective design; each clinician evaluated a different cohort of patients. Nonetheless, it was able to demonstrate that physiotherapist may be the healthcare professional best suited to assist OSs.

In a retrospective audit conducted by Gardiner and Turner (Joanna Gardiner, 2002), the clinical diagnoses made by clinicians were correlated to the final arthroscopic diagnoses. The medical files of 128 patients who underwent arthroscopy for internal derangement of the knee were reviewed. The clinical diagnoses made by an APP and OSs were compared to observations made during the arthroscopies. The APP had greater agreement with arthroscopic diagnoses (52%) than those made by the OSs and residents (37%). Furthermore, there was a therapeutic value for 100% of patients referred by the APP for arthroscopy compared to 79% of patients listed by the doctors. However, it should be noted that the APP saw only 18% of patients in this study (n = 23 vs. n = 105 seen by the doctors), which limits its findings. Additionally, a significant proportion (39%) of patients in the doctors' group were listed by residents in training who may be less competent than their staff, which could have negatively biased the results in this group.

Furthermore, there was no independent auditor. The first author was the sole auditor and thus may have had a potential for bias.

Dickens *et al* (Dickens, Ali, Gent, & Rees, 2003) led a prospective diagnostic accuracy study. Fifty patients who presented to their outpatient knee clinic were assessed independently by two physiotherapists and one OS. Among those patients, 33 required an arthroscopy. The clinical diagnoses made by the clinicians were compared to arthroscopic findings. A correct initial diagnosis was made for 92% of cases by the OS, 84% of cases by the first physiotherapist and 80% of cases by the second physiotherapist. Diagnostic accuracy was highest for anterior cruciate ligament tears. This study is also limited by its small sample size. Considering there were different diagnostic categories, some categories had very few patients (e.g. lateral meniscal tears).

The studies presented above have all demonstrated that APPs possess a high diagnostic accuracy for various musculoskeletal conditions, similar to what OSs are capable of achieving. However, the two studies involving arthroscopy both focused solely on pathologies afflicting the knee. Additional diagnostic accuracy studies would be required to generalize these findings to other commonly encountered problems in orthopedic surgery.

3.4: Patient Conservative Management Concordance between Advanced Practice Physiotherapists and Orthopedic Surgeons

APPs are often required to conservatively manage the patients they do not refer to OSs for surgery. Common modalities of conservative management provided by APPs include requesting additional imaging tests, prescribing medications, performing injections and referring patients to other specialists.

In the study led by Aiken *et al* (Aiken & McColl, 2008), the management recommendations of the APP and OS were noted for each patient. These recommendations included education, exercise prescription, further diagnostic testing, surgery and medications. They found that the APP made more recommendations (n = 77) than the OSs (n = 50). This resulted in an average of two recommendations per patient for the OSs and three per patient for the APP. It was noted that the APP had more tendency to give advice and education as well as prescribe exercises, even for patients who were deemed surgical

by the OSs. The authors seem to insinuate that providing more recommendations results in better care for patients. However, that is not necessarily the case as some recommendations may not be pertinent or justified, leading to needless use of health resources and possible unwarranted harm to patients.

Desmeules *et al* (F. Desmeules et al., 2013) also compared the imaging and conservative treatment recommendations made by their APP and OSs who evaluated the same patients. There was no significant difference between the two consultants regarding the amount of imaging ordered. Overall, the inter-rater agreement for all imaging was good ($\kappa = 0.65$, 95% CI: 0.52−0.79). The highest agreement between the two clinicians was for ordering CT scans (APP n = 24 vs. OSs n = 20; percent agreement = 96%; $\kappa = 0.78$; 95% CI: 0.63−0.93) while the lowest was for ordering X-rays (APP n = 60 vs. OSs n = 50; percent agreement = 75%; $\kappa = 0.48$; 95% CI: 0.33−0.64). As for conservative treatment recommendations, it was found that the APP gave more education to patients, prescribed non-steroidal anti-inflammatories and joint injections more often, referred more patients to a physiotherapist and provided more home exercises than the OSs ($p < 0.001$). Agreement for individual treatment modalities ranged from 23% to 99%.

Razmjou *et al* (Razmjou et al., 2013) only evaluated agreement for additional imaging recommendations made by their APP and OSs in a specialty shoulder clinic. They found that agreement was highest for X-rays (percent agreement = 97%; $\kappa = 0.91$; 95% CI: 0.81−1.00). Low agreement was obtained for MRI ($\kappa = 0.27$; 95% CI: -0.05−0.59) and MR arthrogram ($\kappa = 0.38$; 95% CI: -0.16−0.93). The low frequency of prescription of these imaging tests during the study probably contributed to these results.

In the RCT performed by Daker-White *et al* (Daker-White et al., 1999), patients were managed by either an APP or an OS. It was found that the APP ordered significantly less diagnostic tests when compared to the OS (106/223 patients vs. 185/217 patients). This difference was mostly accounted for by X-ray prescriptions (APP: 31/223 patients vs. OSs: 90/217 patients). There were no statically significant differences for all other investigations. The APP was more likely to record that they gave medical advice and reassurance to patients in his management than the OSs (116/197 patients vs. 63/194 patients; $p < 0.0001$). Conversely, the OSs opted for surgical referral more often than the

APP (33/195 patients vs. 14/197 patients respectively; p = 0.005). They believed that the fact that OSs ordered more imaging and referred patients more often to surgery reflected their training.

In summary, variable approaches were used to compare patient management between APPs and OSs in these studies. No firm conclusion can be made on agreement for imaging and conservative treatment recommendations between the two clinicians due to conflicting results from different studies and lack of data on the subject. However, APPs seem to provide more education and exercises to patients compared to OSs. This concurs well with the traditional role of physiotherapists.

3.5: Patient Satisfaction towards Advanced Practice Physiotherapists in Orthopedic Care

For the APP model to garner more acceptance in orthopedic care and in turn become more commonly employed, patients' perception towards APPs needs to be favorable. What is more, higher patient satisfaction toward care has been associated with better health outcomes such as improved adherence to treatments (Doyle, Lennox, & Bell, 2013). Several studies have evaluated patient satisfaction towards APP-led orthopedic clinics.

These studies compared patient satisfaction towards APP-led orthopedic clinics and standard clinics run by OSs. All have concluded that APPs garnered high levels of patient satisfaction, comparable or sometimes better than when usual medical care with an OS was provided (Daker-White et al., 1999; F. Desmeules et al., 2013; Kennedy et al., 2010; Razmjou et al., 2013; Samsson et al., 2016). However, not all of these studies used a standardized validated satisfaction tool. Furthermore, the majority of these satisfaction studies did not report having informed participants that the contents of their satisfaction questionnaires would be kept anonymous and not shared with the clinicians they saw (F. Desmeules et al., 2012). This may have biased participants to score higher in fear of repercussions to their care. Two of the studies (F. Desmeules et al., 2013; Razmjou et al., 2013) noted time taken by each clinician and deduced that the extra time spent by the APP may have contributed to higher scores. In the study conducted by Daker-White *et al* (Daker-White et al., 1999), the level of satisfaction of referring general practitioners was

also surveyed. They found that the referring physicians were globally satisfied with the work done by the APP. Desjardins-Charbonneau *et al* (Desjardins-Charbonneau, Roy, Thibault, Ciccone, & Desmeules, 2016) reached out to members of the Université Laval community with an online survey to evaluate their knowledge and perceptions on APP model of care for patients with musculoskeletal problems. The survey reported that 91% of responders trusted physiotherapists for treatment of musculoskeletal problems in primary care and 90% were open to the idea of introducing APPs into orthopedic clinics.

In conclusion, patient satisfaction is high towards APPs working in orthopedic outpatient clinics in a variety of settings. The patient satisfaction achieved by APPs is comparable if not better than that obtained by OSs. Most studies used a modified version of the VSQ-9 to evaluate satisfaction (F. Desmeules et al., 2013; Kennedy et al., 2010; Razmjou et al., 2013). Additionally, one study reported high acceptability of an APP model of practice in the eyes of the general public (Desjardins-Charbonneau et al., 2016) and another reported that referring general practitioners were overall satisfied with the model (Daker-White et al., 1999).

3.6: Literature Review Conclusion

Models of practice involving the collaboration of APPs and OSs are emerging. Until now, the great majority APP have been senior physiotherapists with many years of clinical experience and having undergone extensive training. However, there are no standardized training program for developing APPs (François Desmeules, 2011). Research supports the use of physiotherapists as collaborators to OSs in their clinics (Darryn Marks, 2016; François Desmeules, 2011; F. Desmeules et al., 2012; Oakley & Shacklady, 2015). APPs have been shown to have good agreement with OSs in diagnosing patients and triaging surgical cases (Aiken & McColl, 2008; Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013). Furthermore, the diagnoses made by these APPs are accurate (Dickens et al., 2003; Joanna Gardiner, 2002; Moore et al., 2005). They have also demonstrated the ability to maintain or even surpass current patient satisfaction achieved by OSs (Daker-White et al., 1999; F. Desmeules et al., 2013; Kennedy et al., 2010; Razmjou et al., 2013; Samsson et al., 2016).

As of yet, no APP model has been validated using a pre-graduate physiotherapist. Considering the adequate training of a pre-graduate master level physiotherapy student in Quebec, it would be interesting to investigate if a pre-graduate physiotherapy student, after having undergone intensive specific training by OSs and senior physiotherapists, could result in a good APP model in orthopaedic outpatient clinics. Furthermore, such an experience would provide useful information on the requirements for developing a training program for APPs.

Chapter 4: Study Objectives and Hypotheses

4.1: Study Objectives

The great majority of studies evaluating APPs in orthopedic outpatient clinics have involved senior physiotherapists with many years of experience (F. Desmeules et al., 2012; Marks, Comans, Bisset, & Scuffham, 2017). No study has been conducted on a collaborative practice model involving pre-graduate physiotherapists in orthopedics, which if yields positive results, would encourage more physiotherapists to undertake the much needed APP role. Therefore, the general goal of the present study was to investigate a collaborative model of care involving a senior physiotherapy student (PS) taking on the role of an APP in various orthopedic outpatient clinics.

Since the most essential task of APPs is triaging surgical case, the primary objective was to investigate the level of agreement on surgical triage between a PS and OSs for shoulder, knee and hip problems encountered in a collaborative outpatient clinic. Secondarily, the other objectives of the study are listed as follows:

- To evaluate the level of diagnostic agreement between a PS and OSs for shoulder, knee and hip conditions;
- To evaluate the level of agreement for patient management between a PS and OSs handling these orthopedic problems;
- To survey patient satisfaction towards the collaborative outpatient practice model involving a PS and OS.

4.2: Study Hypotheses

Based on the vastly positive findings with senior experienced physiotherapists from the current literature, we believed that the PS in our study would perform at a level equal or slightly inferior to a real APP. In line with our objectives, we anticipated achieving the following results:

1. Clinically adequate level of agreement ($\kappa > 0.40$) between the PS and OSs pertaining to surgical triage recommendations, diagnoses and additional patient management suggestions;

2. High patient satisfaction towards the outpatient clinic involving collaboration between a PS and OSs.

Chapter 5: Methods and Results

5.1: Foreword

The sections Methods and Results are presented in the form of a scientific article in this thesis. This article presents the research findings of the study conducted during my master's degree. I participated in all aspects of the research. My contributions include the following: study conception, creation of research protocol for approval by the ethics committee, data collection, analysis of results and writing of the article as first author.

Advanced practice physiotherapist role in orthopedic surgery triage is not limited to experienced senior physiotherapists

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5.2: Summary of Article (French)

Titre : Le triage chirurgical en orthopédie assumé par les physiothérapeutes en pratique avancée n'est pas limité aux physiothérapeutes séniors expérimentés

Introduction : Les physiothérapeutes en pratique avancée (PPA) ont permis l'amélioration de l'accessibilité aux cliniques externes en orthopédie. Plusieurs études ont validé le modèle de pratique PPA en soins orthopédiques, démontrant une concordance élevée entre les PPA et les chirurgiens orthopédistes (CO) sur le diagnostic et la prise en charge. Les PPA sont généralement des physiothérapeutes séniors expérimentés et un modèle de pratique avec un stagiaire en physiothérapie (SP) n'a jamais été exploré. Le but de cette étude était donc d'évaluer la concordance pour les diagnostics et pour le triage chirurgical entre un SP et des CO.

Méthodes : Une étude prospective impliquant un SP dans sa dernière année d'étude et sept CO a été menée à un hôpital universitaire, après que le SP ait suivi une formation intensive de trois semaines. Quatre-vingt-six patients référés en orthopédie pour gonarthrose, coxarthrose ou problèmes d'épaule ont été évalués individuellement par le SP et ensuite par un CO. Les diagnostics et recommandations de triage chirurgical des deux cliniciens ont été analysés pour concordance utilisant le pourcentage d'accord brute et le kappa de Cohen. La satisfaction des patients envers leurs expériences en clinique externe a été notée utilisant une version modifiée du Visit-Specific Satisfaction Instrument.

Résultats : Notre échantillon comprend 86 patients (âge moyen = 63.4ans). Les problèmes d'épaule représentaient 36% des consultations, la gonarthrose 52% et la coxarthrose 12%. La concordance brute pour le diagnostic était de 95.3%. La concordance pour le triage chirurgical était élevée (κ = 0.86, IC 95%: 0.74–0.98) avec une concordance brute de 94.2%. La satisfaction des patients était élevée.

Conclusion : Le SP et les CO ont posé des diagnostics et triages similaires, ce qui suggère que l'expérience clinique seule ne détermine pas la capacité du physiothérapeute à améliorer l'accessibilité en orthopédie.

5.3: Article

Abstract

Background: Advanced practice physiotherapists (APP) have helped improve accessibility to orthopedic outpatient care. Several studies have validated the APP practice model in orthopedic care, demonstrating high agreement between APPs and orthopedic surgeons (OS) regarding diagnosis and management. However, as APPs tend to be experienced senior physiotherapists, such a study involving a physiotherapy student (PS) has not yet been explored. The purpose of this study was to evaluate agreement for orthopedic diagnoses and surgical triage between a PS and OSs.

Methods: A prospective study involving a final year PS and seven OSs was conducted in a university hospital, after the PS had undergone a three-week intensive training. Eighty-six adult patients referred to OSs for gonarthrosis, coxarthrosis or shoulder problem were independently evaluated by the PS, and then re-evaluated by an OS. The diagnoses and surgical triage recommendations of both clinicians were analyzed for agreement using percentage agreement and Cohen's kappa. Patient satisfaction towards the outpatient clinic experience was noted using a modified version of the Visit-Specific Satisfaction Instrument.

Results: Our sample consisted of 86 patients (mean age = 63.4 years). Reasons for consultation included shoulder problems (36%), gonarthrosis (52%) and coxarthrosis (12%). The percent agreement for diagnosis was 95.3%. The agreement for surgical triage was high (κ = 0.86, 95% CI: 0.74–0.98) with a raw agreement of 94.2%. Patient satisfaction was high.

Conclusions: The PS and OSs made similar diagnoses and triage recommendations suggesting that clinical experience alone is not a prerequisite for physiotherapists to help increase accessibility to orthopedic care.

Level of Evidence: Level II

Introduction

Access to orthopedic care can be challenging for Canadians[1-3], as wait times for referrals in an orthopedic clinic can sometimes exceed two years[2]. The shortage of orthopedic surgeons (OS) means that the current landscape of orthopedic medicine in Canada is plagued by work overload[3]. Moreover, inadequate management and referrals by general practitioners lead to unnecessary consultations by OSs[4], which enhances the problem. Also responsible for the limited access to care is the current practice model in orthopedic medicine which is centered on the physician.

Providing assistance to OSs would help improve accessibility, while reducing workload for these surgeons. In some countries, a new model of practice involving physiotherapists in orthopedic outpatient clinics has been shown to be effective[5, 6]. Physiotherapists working in these new practice models are often referred to as advanced practice physiotherapists (APP). Their primary role is to triage for surgical conditions. Tasks frequently performed by orthopedic APPs include evaluating initial consultations, making diagnoses, ordering laboratory tests and imaging and ensuring follow-up of non-surgical conditions[2, 6]. APPs, though scarce, have been successfully implemented in numerous countries[6-12]. Several studies examining agreement of clinical diagnosis and surgical triage between APPs and OSs show that APPs can establish similar diagnoses as OSs for a variety of musculoskeletal problems, with percent agreement ranging from 75% to 92%[9, 10, 12, 13]. Strong agreement (86−92%; κ=0.69−0.80) has also been shown for triaging surgical patients[9-13]. Furthermore, orthopedic clinics involving APPs have generated high satisfaction[7-10, 12, 14]. Thus, APPs are well suited for seeing new orthopedic consultations in an outpatient setting.

The great majority of current studies evaluating APPs in orthopedic outpatient clinics have involved senior physiotherapists with many years of experience[15]. This fact may intimidate young physiotherapists interested in the APP role. It would be interesting to demonstrate the feasibility of such a practice model with a more junior physiotherapist. No study has been conducted on a collaborative practice model involving pre-graduate physiotherapists. Therefore, the objective of this study was to investigate the level of

agreement on clinical diagnosis and surgical triage between a physiotherapy student (PS) and OSs working in a collaborative model in an outpatient clinic.

Materials and Methods

Design

A prospective inter-rater reliability study of consecutive cases was conducted during a four week period in the orthopedic outpatient clinic of the CIUSSS de l'Estrie-CHUS, Quebec, Canada.

Participants

New patients above 18 years of age referred to our orthopedic outpatient clinics for issues related to gonarthrosis, coxarthrosis or shoulder problems were eligible. Patients were excluded if they did not comprehend French or English, or if they were unable to give an informed consent. The project was approved by the local Ethics Review Board.

Physiotherapy student

A PS in his last year of a master's degree (520 hours of clinical placement experience) was selected to participate and integrate into our orthopedic outpatient clinic during a seven-week clinical placement. Selection was not related to academic performance but rather on the clinical placement matching process. Since introducing a PS in the role of an APP is a novel concept, a more complicated study design involving multiple PS was not undertaken.

Prior to the start of the study, the PS underwent a three-week intensive training with the orthopedic team to become familiar with the APP role consisting of shadowing OSs, attending review sessions on high-yield topics, practicing clinical evaluations of patients and receiving constant feedback on performance from OSs and residents.

Orthopedic surgeons

Seven senior OSs from varying subspecialties participated in our study. All of the OSs have undergone fellowship training and possess at least ten years of experience. They work at teaching hospitals where many orthopedic surgery residents and medical students receive training under their supervision.

Collaborative model in the outpatient clinic

A collaborative model of APP-led orthopedic outpatient clinic was implemented at our hospitals for the purpose of the study. The collaborative model involves a preliminary evaluation (patient history, physical exam and imaging interpretation) of new consultations by an APP and revision of each patient with an attending OS. The OS then personally assesses the same patient to determine the final clinical management to be prescribed. The role of the APP was assumed by the PS in our study.

Data collection and procedures

Socio-demographic characteristics of each participant as well as medical management of the participant's condition prior to their consultation were recorded including previous medication, joint injections, imaging and therapy. Based on this information, the OSs determined the appropriateness of the initial management received by each participant. An initial management was considered ideal when the referring physicians have performed all possible treatment modalities within their scope of practice.

As per the collaborative model, both the PS and OS evaluated each participant independently. A standardized data collection form was created to collect each clinician's clinical decisions. The patients' most likely primary clinical diagnosis was written down. Surgical triage recommendation was noted as either "conservative" or "surgical" treatment. Additional management suggestions were noted as well. These included further imaging, and conservative treatment modalities. The clinicians also decided whether a follow-up with the patient's family doctor or OS was most appropriate.

The PS completed the data collection form immediately after his evaluation, prior to reviewing with the OS. The OS was blinded to the recommended clinical decisions of the PS. The clinical decisions of the OSs were considered the gold standard to which those of the PS were compared to.

Finally, patients' satisfaction towards their experience during their outpatient clinic visit was assessed with a modified version of the Visit-Specific Satisfaction Instrument (VSQ-9) validated by Kennedy *et al*[14]. Two items of the VSQ-9 are related to clinic processes while the other seven are related to service provision by the healthcare

professional, as was determined through exploratory principal-component analysis[14]. The first two items of the questionnaire ("Getting through to the office by phone" and "Length of waiting time at the office") were not included in the analysis as they were not directly related to the collaborative outpatient clinic model. Each item is evaluated on a five point ordinal scale (choice of "Poor", "Fair", "Good", "Very Good" or "Excellent"). Answers to each item undergo a linear transformation to a score of 0 to 100 ("Poor" = 0 and "Excellent" = 100). The total score is calculated as an average of the scores of each individual item. The VSQ-9 has been employed to compare satisfaction between different healthcare professionals and has been validated in different clinical settings[14]. The questionnaire possess a high internal consistency with a Cronbach's alpha of 0.90[14]. A construct validation process using Pearson correlation analyses demonstrated a positive, modest ($r = 0.43$) but significant ($p < 0.001$) association with overall satisfaction after hip or knee replacement surgery[14]. Participants answered the VSQ-9 immediately following their discharge.

Analyses

The participants' clinical characteristics and satisfaction score were analyzed using descriptive analysis. Three senior OSs independently reviewed the clinical diagnoses recorded by the PS and OSs to determine agreement. Differences between the reviewers were resolved through consensus. Raw percent agreement and Cohen's kappa was used to measure agreement of clinical decisions between the PS and OS. The strength of agreement using kappa (κ) was interpreted as suggested by Landis *et al*: 0.0-0.20=slight agreement, 0.21-0.40=fair, 0.41-0.60=moderate, 0.61-0.80=strong and 0.81-1.00=almost perfect[16]. Kappa$\geq$0.41 was considered clinically significant. Results are presented in mean and 95% confidence interval (95%CI).

Sample size was calculated based on triage agreement according to a method proposed by Flack *et al*[17]. An alpha threshold of 5%, power of 80% and bilateral test were used in the calculation. In a study conducted by Desmeules *et al*[10], the proportion of patients deemed surgical was 30.8%. The expected kappa was chosen to be 0.70 according to what was found in the literature[10-12]. A theoretical kappa of 0.40 was chosen. Accordingly, a sample size of 75 patients was needed.

Source of Funding

A research grant for masters training was obtained from the Foundation for research and teaching in orthopedic surgery of Sherbrooke. There were no other sources of funding.

Results

The recruitment of patients is detailed in Figure 1. Eighty-six patients were seen by the PS and included in the study.

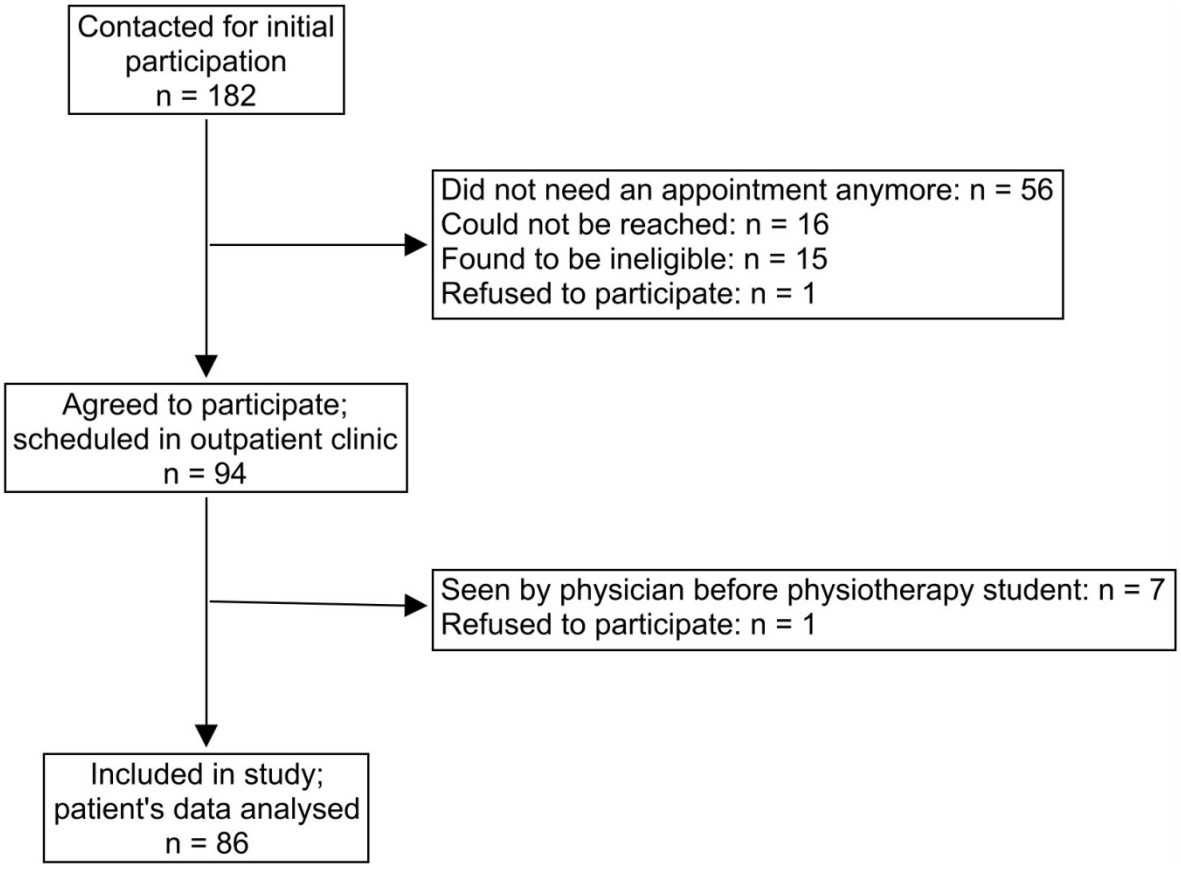

Figure 1: Flow chart of patient recruitment

Clinical Characteristics

Our sample was composed of 86 patients (60% male, 40% female), with an average age of 63.4 years (95%CI: 41.4–85.4).d Reasons for consultations included shoulder problems (36%), gonarthrosis (52%) and coxarthrosis (12%). As for flow of referral, 43% of patients presented during the first half of the study and 57% during the last half.

The initial medical management provided to the patients by their referring physician prior to consultation is presented in Table 1. Oral medication was prescribed to 88% of participants and a topical anti-inflammatory cream to 8%. An appropriate corticosteroid injection was performed in 63% of patients. Almost all participants (95%)

had undergone some form of imaging while 45% had tried a form of non-pharmaceutical therapy (physiotherapy was the most observed at 37%). According to the OSs, only 58% of participants had received an ideal management of their orthopedic problem before their consultation.

Table 1: Previous conservative management of participants.

Management Modality	Frequency	Percent
Oral Medication	76	88%
Non-opioid analgesics	71	83%
Opioid analgesics	11	13%
NSAIDs	40	47%
Pregabalin	4	5%
Corticosteriods	2	2%
Muscle relaxant	2	2%
Amitriptyline	1	1%
Topical Medication		
Topical NSAIDs	7	8%
Appropriate corticosteroid injection	54	63%
Imaging	82	95%
X-ray	81	94%
CT-scan	1	1%
MRI	23	27%
Ultrasound	3	4%
Bone scintigraphy	1	1%
Non-Pharmacological Therapy	39	45%
Physiotherapy	32	37%
Other including CAM*	8	9%

CAM: complementary and alternative medicine
* includes chiropractic, kinesiology, massotherapy, occupational therapy, orthotherapy, osteopath.

Agreement of Clinical Decisions

I. Clinical diagnosis

The initial inter-rater concordance between the three OS reviewers judging diagnostic agreement between the PS and OSs was good (κ=0.65-0.88). The distribution of the clinical diagnoses encountered during the study is listed in Table 2. Raw percent agreement of clinical diagnosis made by the PS and OSs was 95.3%. Shoulder problems contributed to three of the PS's discordant diagnoses and knee problems for one.

Table 2: Primary clinical diagnoses of participants (after validation process by three orthopedic surgeons).

Clinical Diagnosis	Frequency	Percent
Gonarthrosis	34	39.5%
Rotator Cuff Tear	13	15.1%
Coxarthrosis	9	10.5%
Glenohumeral Osteoarthritis	5	5.8%
Unicompartmental Gonarthrosis	5	5.8%
Shoulder Impingement	4	4.7%
Acromioclavicular Osteoarthritis	3	3.5%
Anterior Shoulder Instability	3	3.5%
Rotator Cuff Arthropathy	3	3.5%
Meniscal Tear	2	2.3%
Patellofemoral Osteoarthritis	2	2.3%
Baker's Kyst	1	1.2%
Patellofemoral Pain Syndrome	1	1.2%
Trochanteric Bursistis	1	1.2%

II. Surgical triage

The PS and OSs agreed on surgical triage outcomes for 94.2% of cases (κ=0.86; 95%CI: 0.74–0.98). The OSs considered 31.4% of participants required surgery (Table 3a). The five discordant cases were further analyzed (Table 4). The reasons for the PS's divergent triaging are listed as follows:

- Two cases were the first two patients seen by the PS during the study period and errors in imaging interpretation by the PS led to inadequate diagnoses;
- One case was due to the PS misinterpreting a physical exam;
- One case was due to the PS being unaware of the existence of a new surgical technique;
- One case was due to the PS overestimating the severity of the patient's condition.

Comparison of surgical triage agreement from first half of the study period (Table 3b) to second half (Table 3c) showed possible improvement with time, where raw percent agreement increased from 91.9% to 95.9% while agreement improved from strong (κ=0.75; 95%CI: 0.49–1.00) to almost perfect (κ=0.91; 95%CI: 0.79–1.00). However, this difference was not statistically significant as there exists an overlap of 95% confidence intervals between those two periods.

Table 3: Inter-examiner agreement for surgical triage for a) all patients, b) patients seen during first half of study and c) patients seen during second half of study.

a)

Surgical Triage		**Orthopedic Surgeons**	
		Conservative	Surgical
Physiotherapy Student	Conservative	58	4
	Surgical	1	23
Raw percent agreement = 94.2%; κ = 0.86 (95% CI: 0.74–0.98)			

b)

Surgical Triage Week 1 + 2		**Orthopedic Surgeons**	
		Conservative	Surgical
Physiotherapy Student	Conservative	28	3
	Surgical	0	6
Raw percent agreement = 91.9%; κ = 0.75 (95% CI: 0.49–1.00)			

c)

Surgical Triage Week 3 + 4		**Orthopedic Surgeons**	
		Conservative	Surgical
Physiotherapy Student	Conservative	30	1
	Surgical	1	17
Raw percent agreement = 95.9%; κ = 0.91 (95% CI: 0.79–1.00)			

κ: Cohen's kappa; 95% CI: 95% confidence interval.

Table 4: Detailed descriptions of discordant cases for surgical triage.

Case	Clinical diagnosis	Surgical triage	Reason for wrong surgical triage
1	Coxarthrosis	Surgical	First patient seen during study period; PS made same diagnosis as OS, however deemed condition to be of lesser severity when interpreting X-rays; PS suggested a conservative treatment.
2	Glenohumeral osteoarthritis	Surgical	Second patient seen during study period; PS made wrong diagnosis of rotator cuff tear due to misinterpretation of x-rays; PS suggested a conservative treatment.
3	Patellofemoral osteoarthritis	Surgical	PS made wrong diagnosis of patellofemoral pain syndrome due to inaccurate physical examination of patient; PS suggested a conservative treatment
4	Rotator cuff tear	Surgical	PS made same diagnosis as OS, however was unaware of existence of a rarely performed new surgical intervention (arthroscopic superior capsule reconstruction for irreparable rotator cuff tears); PS suggested a conservative treatment due to perceived inability to operate patient.
5	Gonarthrosis	Conservative	PS made same diagnosis as OS; Patient had previously undergone a meniscectomy on same knee and developed gonarthrosis afterwards; PS deemed the condition to be of greater severity; PS suggested a surgical treatment.

PS: physiotherapy student; OS: orthopedic surgeon.

III. Additional imaging and conservative treatment recommendations

Recommendation of additional management (treatment or imaging) varied between the PS and OSs. Generally, the PS suggested less additional imaging tests compared to the OSs (PS: 15.1% vs. OS: 30.2%) and agreement for these was moderate (κ=0.45). X-rays were the most frequently recommended imaging modality by both the PS and the OS. The majority of patients were deemed requiring some form of conservative treatment by both clinicians (PS: 76.7% vs. OS: 82.6%). Agreement between the PS and OSs for prescribing a conservative treatment modality was weak (κ=0.39). These treatment modalities included advice and education, adjustments to medication, local corticosteroid injection, orthotics, walking aid, exercises and outpatient physiotherapy referral. Detailed results are presented in Table 5.

Table 5: Additional imaging and conservative treatment recommendations made by the physiotherapy student and orthopedic surgeons.

Further Management	Physiotherapy Student		Orthopedic Surgeons		Agreement (κ)
	Frequency	Percent	Frequency	Percent	
Imaging	13	15.1%	26	30.2%	0.45
X-Ray	9	10.5%	19	22.1%	0.50
CT-Scan	3	3.5%	5	5.8%	0.74
MRI	0	0.0%	1	1.2%	0.00
Other Imaging*	1	1.2%	1	1.2%	N/A
Conservative treatment modalities	66	76.7%	71	82.6%	0.39
Advice and Education	43	50.0%	43	50.0%	0.26
Adjustments to Medication	24	27.9%	20	23.3%	0.39
Local Corticosteroid Injection	44	51.2%	40	46.5%	0.49
Orthosis or Walking Aid	5	5.8%	13	15.1%	0.39
Exercises	35	40.7%	24	27.9%	0.47
Outpatient Physiotherapy Referral	11	12.8%	13	15.1%	0.32

N/A: not applicable. * included quantitative computed tomography (physiotherapy student) and ultrasound (orthopedic surgeon)

IV. Most appropriate physician to assume follow-up

Agreement for which physician was most appropriate to assume patient follow-up was almost perfect (κ=0.81; 95%CI: 0.69–0.94) with a raw percent agreement of 90.7% (Table 6). Follow-up with an OS was deemed necessary in 43.0% of patients.

Table 6: Inter-examiner agreement for most appropriate physician to assume follow-up for patients

Most Appropriate Physician to Assume Follow-Up		Orthopedic Surgeons	
		Family Physician	Orthopedics
Physiotherapy Student	Family Physician	44	3
	Orthopedics	5	34
Raw percent agreement = 90.7%; κ = 0.81 (95% CI: 0.69–0.94)			

κ: Cohen's kappa; 95% CI: 95% confidence interval.

Patient Satisfaction

Patient satisfaction in regards to the outpatient clinic model was high with an average total score of 90.0%. Detailed sub-scores for the individual items of the VSQ-9 are presented in Table 7. Mean time taken by the PS to perform his evaluation was 30.9min (95%CI: 18.5–43.3min).

Table 7: Patient satisfaction scores for outpatient clinic model

Question	Mean	Median
Time spent with the health care professional you saw	89.5%	100%
Answers to your questions	89.4%	100%
Explanation of what was done for you	92.2%	100%
Advice and information about exercise and returning to activities	81.8%	75%
Technical skills (thoroughness, carefulness, competence) of the health care professional you saw	91.0%	100%
The personal manner (courtesy, respect, sensitivity, friendliness) of the person you saw	95.3%	100%
The visit overall	90.1%	100%
Total Score	90.0%	100%

Discussion

The results of the current study show that a physiotherapy student (PS) in his final year of studies was capable of making similar diagnoses and surgical triage recommendations as an orthopedic surgeon (OS) for cases of gonarthrosis, coxarthrosis or shoulder problems.

Strong agreement was observed for diagnoses made by the PS and OSs. The PS was capable of differentiating between more nuanced orthopedic entities such as "gonarthrosis vs. unicompartmental gonarthrosis" and "glenohumeral osteoarthritis vs. rotator cuff arthropathy". The PS's ability to correctly diagnose orthopedic entities was similar to that of APPs in the current literature which reported diagnostic percent agreements varying between 69–98%[9, 10, 12, 13]. Furthermore, compared to similar studies, a greater variety of orthopedic problems, spanning three joints, was seen by the PS.

Disagreements between the PS and OSs on clinical diagnosis were limited to a few cases. Most of the PS's misdiagnoses came from patients presenting shoulder problems. Referrals for shoulder problems were generally more challenging as clinicians are required to make larger differential diagnoses.

The main role of APPs has involved determining surgical candidates from orthopedic consultations. The PS has demonstrated exceptional proficiency in surgical triage. His performance was comparable to those of APPs who also reported strong agreement with OSs for surgical triage[9-13]. A learning curve was observed as surgical triage agreement improved from strong during the first two weeks to almost perfect over the last two weeks of the four week study period. However, this was not statistically significant. Disagreements in surgical triage may be attributed to the PS's lack of orthopedic training. Half of these cases were encountered early during the study while the PS was still adapting to his role and the other half were more complex cases requiring advanced knowledge of orthopedic medicine.

The PS and OSs disagreed more often when it came to recommending additional management modalities. Desmeules *et al* also explored further imaging and management recommendations made by APPs. For imaging, they found highest agreement in CT-scan prescription. This could be attributed to the existence of well-defined criteria for CT-scan

use. The lowest agreement was in X-ray prescription and the APP prescribed X-rays less than the OSs[10], similar to what was obtained in our study. While imaging may be necessary for establishing diagnoses, it can also be used to plan surgeries. This differentiation was not specified in our study and therefore may have accounted for the under-prescription of X-rays by the PS.

Desmeules *et al* also observed that their APP prescribed more conservative treatment modalities than OSs[10]. This was not the case with our PS. A possible cause for the discrepancies in management could result from the different preferences of the many OSs involved. Moreover, considering the short training period of the PS, he may not have had enough time to acquire adequate knowledge on medication use. Perhaps counting treatment modalities prescribed by each clinician is not an effective way to collect data for this purpose.

The PS and the OSs agreed strongly on the most appropriate physician to assure patient follow-up. The majority of patients (57%) did not require follow-up with an OS, close to the proportion of patients that did not obtain an ideal management of their problem prior to consultation (42%). It should be noted that 69% of patients in the study did not require a surgical intervention as is similarly reported in previous studies[2, 12]. OSs are physicians trained extensively in performing surgeries for musculoskeletal problems. The fact that most patients referred in orthopedics are not surgical candidates and have not been properly managed by their family physicians may be the most concerning contributor to the lack of accessibility in this specialty. However, some family physicians might be less confident with musculoskeletal problems as they deal with more complex global medical management of their patients. Thus, the implementation of more orthopedic clinics involving APPs seems to be a logical and viable solution.

Finally, patients were overall satisfied with the clinical practice model involving a PS assisting OSs. The VSQ-9 scores obtained are comparable to those from APP-led clinics which also reported excellent satisfaction scores[7-10, 12, 14]. It has been shown that patient satisfaction correlates with time spent with a clinician[18, 19], which could explain the high satisfaction towards APP-led clinics. High patient satisfaction has been shown to correlate with improved health outcomes such as better adherence to treatments[20]. Very

few patients refused being seen by the PS, thus demonstrating the acceptability of such a practice by patients.

Strengths and Limitations

One of the strengths of the current study is that it is the first of its kind to evaluate a PS in the role of an APP in an orthopedic outpatient setting. Unlike other studies conducted on APPs[9-13], the PS was not limited to a single type of orthopedic subspecialty, but saw a wider variety of conditions spanning three major joints. Another strength of the study was that the PS worked with seven different OSs, more than any other study on APPs currently found in the literature. However, our study was limited by having only one PS in one clinical setting. It should be noted that this is a novel study, making it difficult to undertake a more complicated study design at this stage. One may critique that the PS always evaluated patients first and reviewed with OSs. The pre-set order of patient evaluation was chosen to more accurately simulate the reality of what would be encountered in these types of clinics. Furthermore, the OSs' clinical decisions were considered the gold-standard and OSs in teaching hospitals are used to reviewing cases with their students, making it unlikely they would be biased negatively.

Conclusion

The graduating physiotherapy student and orthopedic surgeons made similar diagnoses and triage recommendations suggesting that a lengthy clinical experience alone is not a prerequisite for physiotherapists to help increase accessibility to orthopedic care.

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Chapter 6: Discussion

6.1: Complement to Article

The goal of the present study was to investigate a collaborative model of care involving a senior physiotherapy student (PS) taking on the role of an advanced practice physiotherapist (APP) in various orthopedic outpatient clinics. We hypothesized that the PS would achieve a clinically adequate level of agreement with the orthopaedic surgeons (OSs) pertaining to diagnoses, surgical triage recommendations and patient management suggestions. We also hypothesized that patients would be highly satisfied with practice model involving collaboration between a PS and OSs.

Most of our hypotheses were confirmed. Our results showed that the PS was capable of making similar diagnoses and surgical triage recommendations as an OS for cases of gonarthrosis, coxarthrosis and shoulder conditions. High patient satisfaction was also demonstrated for the collaborative practice model. However, sub-par agreement between the PS and OSs was obtained for patient management recommendations comprising of additional investigations and treatment modalities.

6.1.1: Management of Orthopedic Conditions by Primary Care Physicians

Orthopedics is a surgical specialty and, therefore, cases referred to OSs should mostly comprise of patients requiring surgical intervention. However, this does not seem to be the case in the province of Quebec, Canada. More than two thirds of participants in this study were not eligible for surgery and similar proportions were found in two other studies conducted in Montréal, Quebec (Decary et al., 2017; F. Desmeules et al., 2013). This suggests that primary care physicians are frequently referring their patients without optimizing conservative treatment.

In an attempt to find possible contributors to this problem, the initial medical management provided to patients by their referring doctor was investigated in our study. An initial management is considered ideal when the referring physician has performed all possible investigations and treatment modalities within his or her scope of practice. We found that 42% of referred patients did not receive ideal initial management, which could contribute to the large proportion of unnecessary referrals in orthopedic surgery. To our

knowledge, this is the only study to investigate the relevance and appropriateness of patient management before orthopedic referral.

Orthopedic conditions in primary care medicine can often be managed with medications. For osteoarthritis and many shoulder problems, pain is an important symptom for patients. Our study showed that 83% of patients had been prescribed a non-opioid analgesic and 47% an NSAID prior to their consultation. Nonetheless, the OSs suggested adjustments to the patients' medications in 23% of cases after their evaluation. Non-opioid analgesics and NSAID are simple to prescribe and are well within the scope of practice first line physicians.

Likewise, local corticosteroid and/or viscosupplementation injections may also be helpful for these orthopedic conditions and are also within a general practitioner's capabilities. Our study showed that 63% of referred patients had received proper injections from their family physician. However, the OSs recommended a corticosteriod injection for 47% of referred patients after their evaluation. While these findings demonstrate that a significant percentage of patients did not receive an appropriate joint injection when they needed it, these results also suggest that some family physicians may not have exhausted all benefits from their patients' joint injection therapy before requesting a surgical consultation.

The great majority of referred patients have had some form of imaging done before their orthopedic consultation in this study. After seeing the OS, 30% of participants required additional imaging. While imaging in orthopedic medicine can be useful for making diagnoses, it can also be prescribed for the purpose of planning surgeries. Therefore, the fact that OSs required additional imaging for some patients is not necessarily indicative of poor management by the referring physician. This nuance should be taken into consideration in future studies.

Finally, physical therapy can sometimes improve certain musculoskeletal conditions and thus can be a useful tool for physicians. We found that few patients (37%) were referred to physiotherapy by their family doctor prior to the orthopedic consultation. However, after consultation with an OS, 28% of patients were prescribed exercises and 15

% were given physiotherapy referrals, perhaps suggesting that these modalities of treatments are under-utilised by general practitioners.

While in a perfect medical system, first-line physicians would adequately manage all patients before referring them to OSs, it is understandable that family physicians might feel less confident in their capabilities in effectively managing musculoskeletal problems, considering they deal with global medical management of their patients. A more logical and viable solution may be to further develop the APP role in orthopedic clinics or first line care centers to allow primary care physicians to concentrate their time and efforts on managing health problems that an APP cannot. From this perspective, APPs might benefit primary care physicians as much as musculoskeletal specialists.

6.1.2: Impact of Discordant Cases for Diagnosis and Surgical Triage

For APPs to have a positive impact on accessibility to orthopedic care, they must be able to correctly triage surgical patients (F. Desmeules et al., 2013). The PS we evaluated was capable of achieving a high level of surgical triage agreement with OSs, similar to what was obtained by other APPs (Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013), while seeing a greater variety of orthopedic conditions spanning three articulations. Nevertheless, the PS disagreed with the OSs in five cases (5.8%).

Disagreements in surgical triage can go one of two ways: 1. the APP recommends a surgical treatment while the OS deems the patient requires a conservative treatment; 2. the APP recommends a conservative treatment while the OS deems the patient to be surgical.

In the first case, not much harm is committed to the patient; the patient would be referred to an OS and theoretically receive an appropriate management. However, if too many patients are needlessly referred to OSs by APPs, the benefits brought on for accessibility may be reduced. The second case might be more worrisome from a patient's perspective. A patient requiring a surgical intervention may not end up receiving appropriate medical care or may experience a delay before receiving it, which could potentially lead to prolonged disability or lower quality of life for the patient. It is therefore important to minimize mis-triaged patients that fall into the second situation.

In our study, 27 out of 86 participants were considered surgical by the OSs. Four (15%) of those cases were triaged discordantly as conservative by the PS. This proportion varies between 9% and 30% in other comparable studies involving APPs (Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013). In a real clinical setting, APPs have access to advice from nearby OSs in the clinic and can still refer patients they deem conservative to OSs when they are uncertain regarding the most appropriate management approach to ensure a safe and efficient management of their patients. This element of the clinician's degree of certitude was not evaluated in our study, or in most similar studies (Aiken & McColl, 2008; Decary et al., 2017; MacKay et al., 2009; Razmjou et al., 2013).

It should be noted that even among OSs, there exists some variability of opinions on which patients require surgery (Grove et al., 2016). It is thus not a realistic goal to aim for perfect agreement between OSs and APPs. Rather, the ultimate goal should be to insure safe management of patients by APPs.

6.1.3: Data Collection for Management Recommendations

APPs are generally required to conservatively manage patients that they triage as non-surgical. Some studies have investigated conservative management of patients by APPs (Aiken & McColl, 2008; Daker-White et al., 1999; F. Desmeules et al., 2013; Razmjou et al., 2013). However, half of these studies (Aiken & McColl, 2008; Daker-White et al., 1999) simply count the number of investigation and treatment modalities recommended by the APPs and OSs, rather than compare them for agreement between the different clinicians. It is important to evaluate agreement in order to ensure that APPs are capable of managing their patients properly. Unnecessary investigations and treatments can have unjustified consequences for patients as well as waste health resources.

The current study demonstrated that the PS achieved moderate agreement with the OSs for imaging recommendations. Desmeules *et al* (F. Desmeules et al., 2013) reported similar agreement results with their APP. As reported by Daker-White *et al*, our PS recommended much fewer imaging tests than the OSs. While imaging can be useful for establishing diagnoses in orthopedic medicine, it is also used to prepare operations. This differentiation was not specified during data collection and may have introduced a bias. It

is possible that the PS suggested fewer imaging tests because he recommended imaging only when it was necessary for establishing a diagnosis, while the OSs also prescribed imaging that they needed for an eventual surgery. Therefore, it may not be accurate to suggest better resource utilisation by APPs (Daker-White et al., 1999; F. Desmeules et al., 2013) because they tend to prescribe less imaging tests than OSs. Ideally, an APP would possess a basic understanding of surgical interventions and be able to recognize when imaging can help prepare for common surgeries. Nevertheless, this does not seem to be necessary for APPs to perform well in surgical triage (Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013).

Although the amount of conservative treatment recommendations made by the PS and OSs was similar in our study, agreement between the different clinicians was low. This low agreement may be due to the PS's training. The PS did not receive explicit teaching regarding pharmaceutical prescriptions during his short three-week training. As medication prescription is not a part of standard physiotherapy practice, pharmacology is only partially touched upon during physiotherapy school. Furthermore, the numerous OSs evaluated in our study may have had different preferences for patient management style. This variability between physicians creates an additional challenge for the PS. He may not have had a long enough training to learn the different personal inclinations of each OS.

It is possible that the manner of collecting patient management data was sub-optimal in our study and other similar studies (Aiken & McColl, 2008; Daker-White et al., 1999; F. Desmeules et al., 2013; Razmjou et al., 2013). Comparable health outcomes can be achieved through different management styles. Therefore, disagreements between clinicians on the modalities of treatment to be provided for a specific patient may not indicate improper management. Simply counting and comparing therapeutic choices fails to capture the complexity of clinical reasoning behind those choices. Data collection should more accurately reflect those subtleties.

6.1.4: Training to Become an Advanced Practice Physiotherapist

At the moment, there exists no standardized training program for physiotherapists who desire to become APPs (F. Desmeules et al., 2012). Generally, APPs have been senior physiotherapists with graduate degrees and many years of clinical experience (Aiken &

McColl, 2008; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013). Orthopedic training received by APPs is distinct in each establishment (Aiken & McColl, 2008; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013) and varies in length and content.

The training of the PS in our study was exceptionally short when compared to that of other APPs (Aiken & McColl, 2008; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013). The fact that the PS performed well with such a brief training may suggest that the foundational education received by PSs during physiotherapy school already prepares them well for the APP role. However, additional specialised training in the APP role was essential for the PS to become accustomed to taking on responsibilities outside of his usual scope of practice. A lengthier training would have allowed our PS to better familiarize with imaging and medication prescription. It might also have allowed the PS to become more comfortable with more types of orthopedic pathologies and to cover regions other than the shoulder, knee and hip. Nevertheless, with the training provided, the PS was capable of achieving satisfactory results for diagnosing and triaging selected orthopedic patients, two main tasks undertaken by APPs.

For APPs to become more prevalent in orthopedic clinics, a formal training program needs to be established. An effective training program for APPs should provide physiotherapists with the knowledge and skills to handle their surgical triage role in orthopedic medicine. Proper education on differential diagnoses of orthopedic conditions is essential for an APP training program. The types of orthopedic conditions to be covered during training depend on the needs of the establishment and the allotted timeframe. Criteria for common surgical interventions can be taught using simple management algorithms. These elements are crucial as they help APPs perform their two main responsibilities, diagnosing and triaging patients.

Reflecting on the difficulties encountered by our PS, the current study revealed elements that may benefit from more attention during an APP's training. Imaging and medication prescription are not covered in depth during physiotherapy school and should be addressed during training. In Quebec, Canada, physiotherapists are allowed to administer therapeutic joint injections, but do not receive the training to do so. As

injections can be valuable treatment option in orthopedics, their preparation and administering should be taught to APPs.

6.2: Strengths and Limitations

6.2.1: Strengths

This is the first study to evaluate a PS in the role of an APP in an orthopedic outpatient setting. The study was clinical and pragmatic. The way the outpatient clinics were run closely simulated a real collaborative APP orthopedic clinic. The data collection process imposed few restrictions for the clinicians. For example, the PS and OSs were free to make detailed diagnoses rather than artificially choose from a restricted list of diagnoses.

The training provided to the PS by the participating OSs prior to data collection enhanced his proficiency in orthopedic medicine and was crucial to his success in the role of an APP. Without proper training, we would not expect to have obtained such positive results. Furthermore, information bias was reduced by providing this training.

Another strength of the current study was the involvement of seven OSs, more than any other inter-rater agreement study on APPs (Aiken & McColl, 2008; Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013). Comparing the PS to multiple OSs allowed for more generalizable results. Chances are that the different OSs had varying preferences for managing their patients, and due to this, agreement between the PS and OSs seem unlikely to have been over-estimated.

We included detailed descriptions of discordant cases for surgical triage, something that has not been done in other similar studies (Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009; Razmjou et al., 2013). These results provide additional information on reasons for disagreements between the PS and OSs, which can be used to determine possible improvements that should be made for the training of APPs.

6.2.2: Limitations

The current study only evaluated one PS in one clinical setting, limiting its external validity. A PS in the role of an orthopedic APP is novel, unproven concept, making it difficult to undertake a more complicated study design at this stage. Furthermore, the APP

role for physiotherapists is also quite novel. Most studies involving orthopedic APPs are also limited by evaluating only one APP.

The types of problems encountered by the PS did not span the entirety of conditions that can be seen by an OS in an outpatient clinic. Therefore, our results may not be generalizable to conditions not included in the study. However, we did include a wide variety of conditions spanning three major joints. It was less conceivable to include more types of problems due to the short training period allotted to the PS.

A possible bias arises from the pre-set order of patient evaluation in our study; the PS always saw the patient before reviewing with the OS. This was done so to avoid repetitive questions for patients. The purpose of the study was to evaluate the capacities of the PS and not that of the OSs. By seeing the patient first, the PS was able to note his clinical decisions before speaking to the OS, and thus could not be influenced by the OS. In this type of study, the clinical decisions of the OSs are considered the gold standard. We must therefore assume that their clinical decisions are the most correct. Moreover, the OSs in our study all work in teaching hospitals. They are used to reviewing cases with medical students and residents. It is unlikely that the OSs would be biased negatively after reviewing with the PS. Therefore, we do not believe that the pre-set order of patient evaluation affected the results.

The data collection method for additional management recommendations is also a limitation of the study. The investigation and treatment decisions of each clinician were simply tallied and compared between clinicians. This does not reflect the reality of clinical practice because this fails to reveal the complex clinical reasoning behind the decisions. Future studies should also record the clinician's reasons for each recommended management modality

6.3: Future Research

Our results suggest that junior physiotherapists may possess adequate skills and knowledge to function in the role of an APP in orthopedic surgical triage. However, as stated above, the study was limited by having only one PS in one clinical setting evaluated. Now that the proof of concept has been established, a logical follow-up study would be to

replicate the current study with more PSs in more clinical settings. This would provide results that are more generalizable and if positive, would further demonstrate that the APP role is not limited to only senior physiotherapists with many years of experience. Furthermore, with the experience gained from the current study, the data collection process can be improved to better reflect the reality of a clinician's evaluation of orthopedic patients.

In the current literature, inter-rater agreement studies involving APPs and OSs have been limited to few conditions. The most common problems seen involve the knee (Aiken & McColl, 2008; Decary et al., 2017; F. Desmeules et al., 2013; MacKay et al., 2009), hip (F. Desmeules et al., 2013; MacKay et al., 2009) and shoulder (Aiken & McColl, 2008; Razmjou et al., 2013) joints. Branching to other orthopedic conditions would increase the applicability of the APP model of care and may better convince stakeholders of the model's utility.

At this moment, there exists no formal training for physiotherapists who desire to become APPs (F. Desmeules et al., 2012). In order for APPs to become more prevalent in orthopedic medicine and have positive impacts on accessibility to care, a standardized, recognized training program needs to be established. The process of creating a formal training program for APPs could be explored in order to create a high value, standardized training program.

Chapter 7: Conclusion

Advanced practice physiotherapists can play a crucial part in helping increase accessibility to orthopedic care in Canada. The current study is the first of its kind to evaluate a pre-graduate physiotherapy student in the role of an orthopedic advanced practice physiotherapist. The physiotherapy student was able to make similar diagnoses and triage recommendations as an orthopedic surgeon for knee, hip and shoulder conditions. Furthermore, patients were very satisfied with the collaborative practice model involving the physiotherapy student and orthopedic surgeons. While a study implicating more physiotherapy students and orthopedic surgeons would provide stronger evidence, the results of the current study suggest that a lengthy clinical experience alone is not a prerequisite for physiotherapists to participate in orthopedic care. Proper training in orthopedic medicine is probably at least as or more important than clinical experience for success as an advanced practice physiotherapist

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